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McGILL UNIVERSITY

PAPERS FROM THE DEPARTMENT

OF

BOTANY.

No. 5.—MYELOPTERIS TOPEKENSIS, n. sp.

BY

D. P. PENHALLOW.

WITH PLATES II. AND III.

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MONTREAL, 1897.

MYELOPTERIS TOPEKENSIS, N. SP.

A NEW CARBONIFEROUS PLANT.

D. P. PENHALLOW.

(WITH PLATES II AND III)

DURING the past sixty years a number of plants, variously described under the names of Medullosa[1] (1832), Palmacites[2] (1845), Myeloxylon[3] (1849), Stenzelia[4] (1864), and Myelopteris[5] (1874), have been obtained from the Carboniferous of France, Germany and Great Britain, but, so far as I am aware, no representative of this group has been obtained heretofore from any locality in America.

Recently Professor C. S. Prosser has sent to me three small specimens of flattened stems from the upper Carboniferous of Topeka, Kansas. These fragments are about 6^{cm} long and lie in a matrix of calcite.[6] One specimen represents the full width of the original structure and is 33^{mm} broad. A second has the edges broken off, but a natural extension of the curvatures of the sides shows the probable breadth to have been about 6^{cm}. Both of these specimens have been compressed into a flattened mass having a lenticular transverse section with a maximum thickness of 5^{mm} and 8^{mm} respectively. A third specimen, flattened to an irregularly lenticular mass, represents thin layers of plant residue adherent to the sides of the matrix, and obviously but a small part of the original structure. The dimensions of breadth here given represent very nearly the

[1] Cotta : Die Dendrolithen in Beziehung auf ihren inneren Bau. Dresden, 1832.

[2] Corda : Beitr. zur Flora der Vorwelt. 1845.

[3] Brongniart : Tab. des gen. de vég. foss. Dict. Univ. d' Hist. nat.

[4] Goeppert : Die foss. Fil. der perm. Form.

[5] Renault : Étude du gen. de Myelopteris. Acad. de Paris **22** :—1875. [no. 10.]

[6] I am much indebted to Dr. B. J. Harrington for determinations of the mineral constituents of these fossils.

diameter of the structure in its original form. The general color is that of brown coal. The surface shows occasional areas of thin coaly matter much broken up into small angular fragments, but it is chiefly characterized by a somewhat finely striated appearance due to removal of the cortical layer, with consequent exposure of the underlying strands of sclerenchyma.

The transverse section of the more perfectly preserved specimen shows an outer zone 1.5^{mm} thick, which is continuous on all sides. Central to this and thus forming the axis of the original structure, is a distinctly darker and somewhat more porous mass, containing, here and there, small irregularly rounded masses of pyrite. Upon subsequent microscopical examination, these zonal appearances were found to be due to well defined differences of structure.

The microscopical details present many features of interest and, although the general effects of decay and compression have been to completely destroy the general relations of parts, and in many cases, also, to destroy structural details, these last have been preserved, in some instances, in a remarkably perfect manner.

THE CENTRAL AXIS.—The entire central portion of the stem presents a complete absence of structural detail. The whole central area is occupied by a mass of dark colored material so disposed as to indicate its probable derivation from thin walled tissue, but much altered by decay and the subsequent effects of extreme compression. Here and there, dark colored masses appear, possibly the residue of the mucilage originally present. Throughout this region large rounded openings appear, and while some of these undoubtedly represent the displacement of pyrite, many, and probably all, represent the former locations of vascular bundles. In the dark color and structural character of this area, we find ample reason for its evident separation from the cortical zone, as ascertained upon microscopical examination. Outwardly, this area is limited by a somewhat well defined but narrow and irregular darker line, which is obviously composed of much compressed thin walled cells, but which, nevertheless, seems to suggest a somewhat definite boundary line between a

central medulla in which thin walled fundamental tissue predominates, and a somewhat rigid, or at least firmer, outer zone.

THE CORTEX.—No proper cortical structure is represented in these specimens. The outer limits of the sections are defined by more or less broken down strands of sclerenchyma cells, with surrounding parenchyma tissue, making it clear that a certain amount of structure has been removed; and this accords with what has already been noted in specimens of Myelopteris, that "the tissue layers outside the sclerenchyma strands are very rarely preserved."[7] In this case the thin surface layers of coal already described are in all probability to be regarded as representing the cortical structure, which must have been chiefly or wholly parenchymatous in character, and of small radial volume.

THE SUB-CORTICAL LAYER.—The outer, continuous zone, 1.5^{mm} thick as already described, has its macroscopic differentiation from the medulla explained by the large amount of fibrous elements which it contains. Owing to the presence of these elements, and the peculiar way in which they are distributed, they have served not only to protect one another, but they have also served to prevent the effect of compression from falling with full force upon the intervening fundamental structure which in consequence, has often retained its structural features in an exceptionally perfect manner (*figs. 1* and *2*).

PARENCHYMA.—The ground tissue, for the greater part, is much altered by decay and compression, so that all structural features, especially in the central area, have been pretty completely eliminated. Occasionally, however, when protected by earlier infiltration and petrifaction, or by the resisting character of the accompanying strands of hard sclerenchyma, this part of the structure has been preserved in a very beautiful manner (*figs. 1* and *2*). From these areas it is possible to determine the fact that this tissue consists of very variable, but chiefly large and thin walled elements of such a character as to remind me very forcibly of the fundamental structure in many of the larger ferns.

[7] Solms-Laubach: Foss. Bot. 162.

The intercellular spaces ordinarily met with in such tissue are present, but there is no evidence of the existence of lacunæ.

SCLERENCHYMA.—It has been shown already that the subcortical zone is 1.5^{mm} thick. Within this region there are numerous oval or tangentially elongated bundles of sclerenchyma, which form long strands traversing the stem longitudinally for great distances (*figs. 1, 2,* and *3*). These strands, which give the peculiarly striated appearance to the surface of the specimen wherever exposed, are always separated from one another by several large and thin walled parenchyma cells (*fig. 1*), which are seen to be very perfectly preserved in certain areas. The sclerenchymatous elements are always very thick walled in those strands which lie next the cortex (*fig. 3*), but become much thinner walled toward the center of the stem where they often appear to be in a formative condition. The strands are separated radially by rather wide areas of fundamental tissue (*fig. 2*), but in consequence of the general and great alteration in relative positions effected by compression, it is impossible to determine their original distribution. The radial distribution of these strands through a rather wide zone would seem to indicate that they may have been developed in more or less well defined concentric layers, a relation which is certainly implied by their distribution within certain areas (*fig. 2*). Beyond a limit of 1.5^{mm} from the surface the development of the strands appears to be wholly arrested.

VASCULAR BUNDLES.—The vascular bundles are not frequently represented, since in most cases they have been removed by decay, or other causes, and their former positions are then marked by the presence of rather broad, irregularly rounded openings of variable dimensions, which appear throughout the transverse section (*figs. 1, 2,* and *3*), and particularly internal to the sclerenchyma zone. Occasionally the bundles are preserved in a very perfect manner, and exhibit all their essential structural features with great clearness (*fig. 1*). The outermost of the two bundles seen in *fig. 1*, when much enlarged (*fig. 4*), is found to consist of several broad scalariform ducts enclosed on two

sides by rows of thick walled fibrous elements. The phloem, rather small in volume, is here much broken down, but it is situated radially outward, while in the other bundle (*fig. 1*), where it is rather more perfectly preserved, it is situated radially inward. The protoxylem is here seen as a group of smaller elements much altered by compression (*fig. 4*), or in other instances more perfectly preserved (*fig. 1*), sometimes on the outer face of the vessels, and sometimes on the inner face, but always between them and the phloem. While the bundles vary considerably in size, they all conform to the collateral type and it is of interest to note that in all their structural features, they agree very closely with the bundles of a species of Myeloxylon described by Solms Laubach,[8] and also by Seward.[9]

From the present material I have been wholly unable to obtain satisfactory details of the structure of the bundle in longitudinal section, beyond the fact that the vessels are distinctly scalariform, and in this respect they conform to the type generally observed in ferns.

The peculiar situation of these bundles is not altogether easy to account for. They certainly appear to lie between, and are therefore mingled with, the strands of sclerenchyma, from which circumstance I was at first led to suppose them to be collateral, as in the case of Phoenix and other palms, but a very careful examination fails to disclose any satisfactory evidence of such relationship, while in some cases at least the vascular bundle is separated from the nearest sclerenchyma strand by a broad zone of fundamental tissue. Indeed, the evidence, so far as obtainable from the present material, seems to indicate that these bundles and the sclerenchyma are altogether independent of one another; but in the present unsatisfactory condition of the material now available, no final conclusion can be drawn. From the evidence at hand, however, it would seem that the vascular bundles have their extreme outward distribution in the central portion of the sclerenchyma zone. From this position they

[8] Foss. Bot. 161, *fig. 14 B*.

[9] Ann. Bot. 7: *pl. I* and *II*, *figs. 1, 9, 14*.

increase in number toward the center and become most numerous within the central region.

SECRETORY ORGANS.—A notable feature of the present fossil is the occurrence of numerous large mucilage passages. As a rule these structures are much altered by decay and compression, but in two instances they were found in a very perfect state of preservation (*fig. 2*). So far as it is at present possible to determine, these organs occur throughout the sub-cortical region where they are in more or less intimate association with the sclerenchyma strands. Elsewhere it is not possible to determine the distribution satisfactorily, but, from our knowledge of their occurrence in recent plants, it is a fair inference that they must also be distributed through the entire body of the fundamental structure.

Measurements of such of these passages as were in a sufficient state of preservation for such a purpose showed them to have the following dimensions: $155 \times 100\mu$; $205 \times 135\mu$; $215 \times 145\mu$. From these results it is possible to deduce an average dimension of $127 \times 192\mu$. From this again it appears that these passages may be described as of elliptical form, in which the minor and major axes have a ratio of 1 : 1.5. The very great size of these structures, unusual except in a few groups of plants, seems to suggest a comparison with both Cycadaceæ and Marattiaceæ. In structure they are simple. Longitudinally they form long tubular passages which traverse the stem for great distances. In transverse section they consist of large elliptical openings bounded by a very regular wall composed of parenchyma cells often differing but little from those of the surrounding tissue. They are more commonly somewhat elongated tangentially to the central canal, and by analogy with similar structures in recent plants we may infer that they contained active protoplasm. They thus form the secretory cells, or an epithelium which is not specially differentiated (*fig. 3*). A comparison of the two canals (*fig. 2*) will serve to show, however, that the secretory cells often show little or no deviation from the general character of the fundamental structure.

Another important feature of these canals is to be found in the fact that they are always devoid of contents. This appears to justify the view that whatever they may have contained originally was of a soluble nature and thus passed out of the body of the plant during the process of petrifaction.

In all their principal structural aspects these canals bear a strong resemblance to those of *Angiopteris evecta* (they are of the same type), and it may also be pointed out that they are similar to those found in *Rachiopteris Williamsoni* which Seward has recently separated from Myeloxylon,[10] as also to those of Myeloxylon itself.[11]

Throughout the transverse section of the Topeka specimen there are numerous resinous or coaly masses of very variable size, but evidently originally contained in special channels or cells, which have become much disorganized, and the details of which cannot now be made out. In longitudinal section these masses are of indefinite length, but rather frequently septate. From these features it is possible to refer them to the residue of resin masses which the plant originally contained, and they are, therefore, directly comparable with the similar resin bodies found in recent plants, particularly those of *Angiopteris evecta*.

It is thus fairly certain that in the Topeka plant there were originally at least two, and possibly more, kinds of secretory organs, the one holding mucilage, the other resinous matter, and in these respects our plant is once more comparable with certain recent forms.

The general view of the internal structure thus obtained permits us to gain some conception of the real composition of this stem or stipe, from which we may infer that a restoration would show a cortical layer of parenchyma at least several layers of cells thick, containing numerous mucilage passages. Following this is a sub-cortical zone distinguished by the presence of numerous rather widely separated strands of sclerenchyma, the elements of which are very thick walled toward the cortex, but

[10] Ann. Bot. **8**: *pl. XIII, figs. 8 11 C iv.*

[11] Ann. Bot. **7**: *pl. I, figs. 1, 9.*

continually thinner walled toward the medulla. These strands usually have an accompanying mucilage passage on the outer face, and are in constant (?) process of formation toward the center. Within this zone, vascular bundles, distinguished by their broad scalariform vessels, appear, and increase in number toward the central region. The central axis consists of a rather broad tract of parenchyma tissue, through which the vascular bundles are distributed in large numbers.

From this point of view, and with due allowance for the effects of compression, it is possible to trace a striking similarity in several respects to a species of Myeloxylon described by Solms-Laubach,[12] and more particularly in certain respects to specimens of Myelopteris described by Williamson.[13] The evidence is both clear and direct that this plant must be considered as belonging to that peculiar group for which the name Myelopteris, proposed by Renault, has been most generally employed.

In 1832, Cotta described certain fossils from the Carboniferous of Europe under the name of Medullosa, which has more recently become merged in that of Myelopteris. Williamson, however, informs us that Cotta's figures of *M. elegans* are wholly misleading, the structure being represented in a much exaggerated form, while his two species, *M. stellata* and *M. porosa*, remain too obscure to be depended upon without further evidence than has come down to us.[14] The genus Medullosa, nevertheless, constitutes the basis of that group of plants which, passing under several names, has finally come to be known under that of Myelopteris.

In 1845, Corda assigned to his genus Palmacites two plants from the Coal Measures of Bohemia, under the names of *P. carbonigenus* and *P. leptoxylon*.[15] An examination of Corda's figures shows that there is no very great resemblance, although

[12] Foss. Bot. 161, *fig. 14A*.

[13] Foss. plants of the Coal Measures. Phil. Trans. **166**: *figs. 1, 3, 4*.

[14] Foss. plants of the Coal Measures. Phil. Trans. **166**[1].

[15] Flora der Vorwelt 40, 41. *pl. 19, 20*. 1845.

there is a suggestion of similarity to our plant in the general character of the fundamental tissue, and the presence of numerous mucilage passages. These latter, however, are small and apparently altogether separated from the vascular bundles.

Subsequent observers have not been unmindful of certain structural aspects in these plants, which have seemed to suggest their possible relationship to the palms, and more particularly to that type of structure represented in the genus Dracæna, but much doubt has always been entertained as to the possibility of monocotyledons occurring so far back as the Carboniferous. These doubts were first prominently expressed by Brongniart as the result of comparing with the plants figured by Cotta and Corda, new material obtained from Autun, France.[16] He says "il y ait des différences fort essentielles et què rendent très difficile d'établir des rapports entre ces fossiles et les végétaux vivants." He therefore preferred to regard Cotta's *Medullosa elegans* as the representative of a new genus, for which he proposed the name Myeloxylon, which thus seemed to indicate the leading structural features indicated by the former name, the significance of which was thereby perpetuated.

Fifteen years later, Goeppert, in reviewing Cotta's species, regarded *Medullosa elegans* as possessing characters which were variously represented in the gymnosperms, in palms, and in the ferns. As a generalized type, he applied to it the name of Stenzelia.

In 1873, Williamson first drew attention to the belief that the relations of these fossils had not been correctly interpreted, and expressed the view that they were really ferns allied to the Marattiaceæ.[17]

In 1874, Renault reviewed the fossils obtained from the Carboniferous beds at Autun, as a result of which he supports the conclusions reached by Williamson, and while he regards the name proposed by Corda to be wholly untenable, and those of Cotta and Goeppert to be insufficiently indicative, he views that

[16] Tab. des gen. de Vég. Foss. 60. 1849. (Quoted from Williamson.)

[17] Brit. Ass. Adv. Sci. 1873.

of Brongniart with favor, but regards a different form as more expressive of the relationship which he determined.[18] He therefore says: "Pour conserver le nom, premier en date, donné par M. Brongniart à ces portions de plantes, et en même temps pour rappeler leur nature, je les designerai sous le nom de Myelopteris."

The yet more recent studies of these plants by Williamson led him to admit the force of the arguments employed by Renault and the appropriateness of his name.[19] Reference to Williamson's figures discloses several points of resemblance between his specimens and my own. This is to be noted first in a great similarity with respect to the general distribution of tissues, particularly as exhibited in his *figs. 3* and *4*, as likewise in the very general removal of the vascular bundles. The vascular bundle given by him (Williamson, *fig. 7**) is closely similar to that derived from the Topeka specimen (*fig. 4*), but differs materially from his other representation (Williamson, *fig. 7*) taken from the upper end of a rachis, which is closely similar to bundles observed by me in *Dioon edule*, whereby it offers some basis of comparison with the Cycadaceæ.

In longitudinal section the resemblance is rather close, but in this aspect the Topeka specimen offers little evidence of a satisfactory nature beyond the general relations of parts, and the structural markings of the vessels which are seen to be scalariform, as in the ferns.

Finally, the relation of the mucilage passages to the vascular bundles (Williamson, *fig. 14*) and of the very large, elliptical mucilage passages to the sclerenchyma strands (Williamson, *fig. 13*), as also the very thin walled elements of the fundamental structure, all present features almost identical with those observed in the Topeka specimens (*figs. 1, 2, 3*).

Williamson's specimens appear to differ from my own chiefly with respect to the particular distribution of the sclerenchyma strands in the cortical region, a difference which, however, is

[18] Recherches sur les végétaux silicifiés d'Autun. (From Williamson.)

[19] Fossil plants of the Coal Measures. Phil. Trans. 166'.

more specific than generic, but my material has been so altered by compression that I should hesitate to place much reliance upon these aspects of structure, preferring rather to establish the affinity by means of the more perfectly preserved structural elements.

The distribution of the vascular bundles in concentric zones, as described by Williamson, may also be a feature of the Topeka specimen, but for reasons already stated this cannot be asserted with any degree of confidence.

More recently Solms-Laubach[20] has reviewed the entire relations of this group of plants, and while he rejects Renault's name because he regards the evidence as not altogether satisfactory, he prefers to retain Brongniart's name of Myeloxylon "rather than Stenzelia, because it is better known." He gives two figures, one of a general transverse section, the other of a separate vascular bundle, and it is of considerable interest to note that this latter is almost the exact counterpart of a vascular bundle obtained from the Topeka fossil (*fig. 4*). His general view of the structure is not so satisfactory, but it nevertheless exhibits a close similarity to my own material in all its principal features.

Solms-Laubach dissents from the conclusions of both Renault and Williamson, holding that there are strong reasons, on anatomical grounds, for considering the alliance to be with the Cycadaceæ, and cites *Medullosa Leuckarti* as probably affording important evidence in support of this view.

The most recent contribution to our knowledge of these plants is that offered by Mr. A. C. Seward, who has not only reviewed the material originally described by Williamson, but has made a detailed study of specimens contained in the Binney collection of the Woodwardian Museum, Cambridge, as well as of new material derived from the Millstone grit of Lancaster.[21] The diagnoses show that his material is generically the same as that represented by the Topeka specimens as described. In a

[20] Foss. Bot. 161. 1891.

[21] Ann. Bot. 7: 1.

second paper, the same authority makes a study of certain specimens contained in the Williamson collection and originally included by Williamson in the genus Myelopteris, but which he finds to be in reality quite distinct. He therefore separates them under the name of *Rachiopteris Williamsoni*.[22] This species is quite distinct from our Topeka specimen with respect to the character of the vascular bundles, which are concentric, and thus show a distinct approach to the type represented in *Angiopteris evecta*. On the other hand, the mucilage passages, which are also of the type found in Angiopteris, are essentially the same as those of the Topeka specimen, differing only in distribution.[23]

From the review thus presented, it is quite clear that our specimen must be regarded as a species of myelopteris, according to the name adopted by Renault and Williamson, and retained by me as expressing its probable relations, but that it differs specifically from any of the specimens heretofore described. It may be concluded further that the present material represents the stipe of a frond, rather than the stem proper.

Heretofore the representatives of this genus have been derived wholly from the Carboniferous of Europe. The material now at hand from the Upper Carboniferous of Kansas thus affords important evidence as to the wider geographical range of these plants, while the well preserved condition of portions of its structure permits a further discussion of its possible affinities. I have, therefore, carefully passed in review such species of living plants as are available in the Botanic Gardens of McGill University, as affording a possible solution of this question. In prosecuting these studies, I have had in view the suggestions of earlier investigators, as well as those which naturally arose in my own mind upon making a preliminary examination of these fossils. I have, therefore, carefully examined *Cordyline terminalis*, *Phoenix dactylifera*, *Kentia Fosteriana*,

[22] Ann. Bot. **8** : 207.

[23] Ann. Bot. **8** : *pl. 13, fig. 8.*

Latania borbonica, *Cycas revoluta*, *Dioon edule*, *Zamia integrifolia*, *Cibotium regale*, and *Angiopteris evecta*.

A close comparison of the Dracæna type, as represented by Cordyline, shows that any suggestion of resemblance which might at first appear, has no real basis in structural characters, while in many essential respects there is a very wide difference. Noteworthy points of resemblance being absent, it is wholly unnecessary to enter into a more detailed consideration of the structural aspects of this type. Very nearly the same observations are applicable to the palms. In this group of plants, however, there is a somewhat closer point of contact to be found in the mucilage passages. Here these structures appear as tubular channels of great length, and in this respect, as well as in their distribution and great number, there is a general resemblance to the Topeka fossil. Their detailed structure is, on the other hand, quite different, and it points to a want of affinity which is supported by the structure and distribution of the vascular bundles, as also the character of the fundamental structure, and no very searching comparison is required to establish the fact that the affinities of our fossil must be sought elsewhere.

By several authorities the Cycadaceæ have been suggested as affording a satisfactory basis of comparison, a view which, in more recent times, appears to have been particularly urged by Solms-Laubach,[24] although he elsewhere agrees with other observers that certain exceptions which have been taken to the cycadaceous character of the Medullosæ are well founded.[25]

Mr. Seward, yet more recently, has given expression to the same view, basing his opinion upon a very critical examination of a large amount of material.[26] While admitting the many points of resemblance to ferns, he holds that in the position of the protoxylem and in the structure of the mucilage passages, as also in the distribution of the sub-cortical sclerenchyma, there are strong reasons for considering the affinity to be with

[24] Foss. Bot. 161.

[25] *Ibid.* 100.

[26] Ann. Bot. 7: 18.

the cycads rather than with the ferns. Without hoping to settle this question at the present time, it may be profitable to consider some of the arguments advanced by Mr. Seward in the light of evidence obtained from an examination of material derived from existing species, as also from the Topeka specimen itself.

VASCULAR BUNDLES.—An examination of both cycadaceous plants and *Angiopteris evecta* affords but little evidence contrary to the view urged by Mr. Seward. The evidence obtained shows, as he contends, that the position of the protoxylem in these plants is certainly an argument in favor of the cycadaceous character of Myeloxylon. On the other hand, the collateral character of the vascular bundles in the latter cannot be taken as final evidence of affinity either with the ferns or with the cycads, as Mr. Seward himself points out. Although the longitudinal sections of the Topeka specimens have given far from satisfactory results, the evidence to be derived from them indicates a much closer resemblance to Angiopteris than to any of the cycads I have been able to study.

SECRETORY ORGANS.—In the Cycadaceæ, as represented by *Cycas revoluta*, *Zamia integrifolia*, and *Dioon edule*, the secretory organs appear to be all of one kind as represented by mucilage canals. These structures are distributed throughout the fundamental tissue and are represented by broad canals which are chiefly limited by tangentially elongated parenchyma cells. These latter, therefore, differ somewhat conspicuously from the cells of the surrounding tissue, as already shown by Mr. Seward.[27] So far as appears from the species above indicated, however, these canals are always lined with a layer of very thin-walled epithelium cells, which become ruptured with age and, shrinking back upon the main wall of the canal, give it a thickened and very ragged appearance.

In *Angiopteris evecta* there are three distinct kinds of secretory organs: (*a*) tannin sacs, (*b*) resin canals, and (*c*) mucilage canals.

[27] Ann. Bot. **8**: 214.

Tannin sacs.—In transverse section the tannin sacs are often barely distinguishable from the resin canals, by reason of their structural similarity. They occur abundantly in the cortex and throughout the fundamental tissue, and especially in close proximity to or within the limits of the vascular bundles. To me these appear to be the structures referred to by Mr. Seward in his description of *Rachiopteris Williamsoni*, when he says, "there are smaller canals in the peripheral part of the phloem of each bundle."[28] In longitudinal section these sacs are seen to be of about the same diameter as in the transverse section, except in the cortex, where they assume the form of cylindrical cells about three or four times longer than broad. The contents are much lighter colored than those of the resin canals, and often present a well defined granular appearance. They readily yield the characteristic reactions for tannin.

Resin canals.—Throughout the sub-cortical zone, scattered among the sclerenchyma cells and also central to each of the isolated strands, are rather broad canals of indefinite length. Throughout the fundamental tissue, particularly in the neighborhood of the vascular bundles, there are also numerous canals which differ but slightly in their structural aspects from the surrounding cells. In all cases, however, they are at once recognizable by the rather dark red resinous mass which each contains. In longitudinal section the canals are of indefinite length. The contents are often septate. These structures appear to me to be comparable with the black, resinous masses of variable size to be met with not only in the Topeka specimen, but in most of the European specimens of Myeloxylon.

Mucilage canals.—Throughout the ground tissue of Angiopteris there may be seen broad openings bounded by more or less tangentially elongated cells. These are the canals from which issue the very large volume of mucilage freely liberated when the stipe is sectioned. These canals are always limited by cells which differ but little from those of the surrounding tissue, except that they are more or less elongated tangentially. Here

[28] Ann. Bot. 8: 214.

there is no specially differentiated epithelium, and in this respect we meet with a feature which serves to sharply separate these structures from those of the Cycadaceæ. On these grounds I should feel no hesitation in deciding as to whether a given plant were cycadaceous or filicoid in its affinities. From this point of view, then, it would seem that the Topeka specimen is more nearly allied to ferns, and the same would hold true of Myeloxylon, if we are to base an opinion upon the excellent figures of Mr. Seward.

SUB-CORTICAL SCLERENCHYMA.—The distribution of the sclerenchyma can hardly be taken as an argument one way or the other, since in both ferns and cycads there is such wide variation. I should consider this a specific rather than a generic character. In all of the myeloxylons so far studied, the sclerenchyma is distributed in separate strands. In the cycads studied by me this tissue forms a continuous band in all cases where strongly developed. In Angiopteris it forms a continuous zone of considerable thickness, with separate strands lying along the inner face.

A résumé of the results above detailed shows that in the Topeka specimen there are characters which directly connect it with *Rachiopteris Williamsoni*, and also with other European species of Myeloxylon, and the evidence would seem to indicate that few of these can be separated generically. Admitting the force of some of the objections raised by Mr. Seward respecting the filicoid character of Myeloxylon, there are, nevertheless, strong arguments in favor of this view, which seem to me to preponderate and thus to justify the retention of the name Myelopteris as a name expressive of this possible relationship; while the fact that these plants do not conform closely to any modern type would seem to raise a question as to the possible correctness of the view originally expressed by Goeppert that these plants in reality represent a generalized type occupying a position between the cyads and the ferns.

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EXPLANATION OF PLATES II AND III

PLATE II

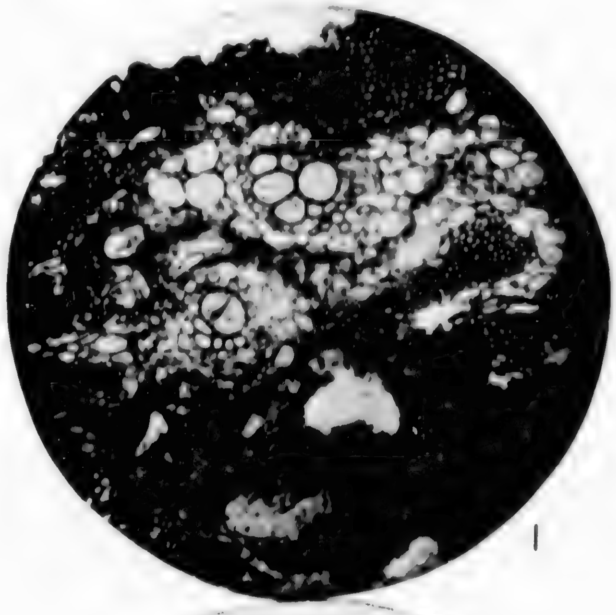
FIG. 1. Transverse section showing the sclerenchyma strands, the fundamental tissue, and two vascular bundles. × 48.

FIG. 2. Transverse section showing the sclerenchyma strands, with two large mucilage passages. × 48.

PLATE III

FIG. 3. Transverse section of a sclerenchyma strand showing details of structure in a mucilage passage on its outer face. × 180.

FIG. 4. Transverse section of a vascular bundle showing details of structure. × 180.



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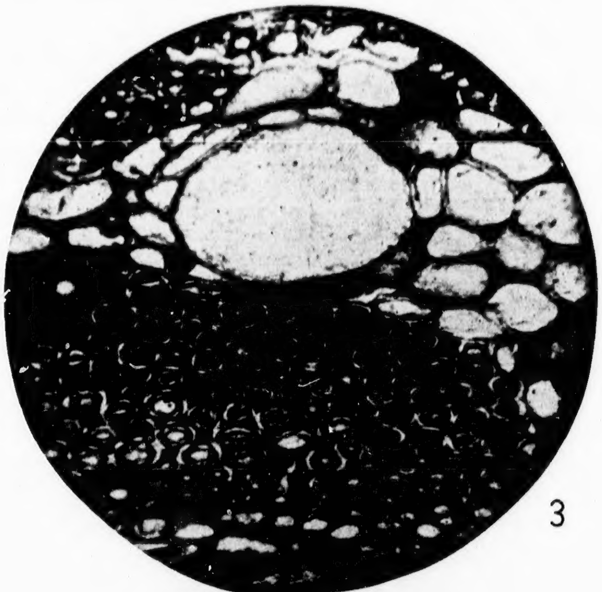
MYELOPTERIS TOPEKENSIS Penhallow.



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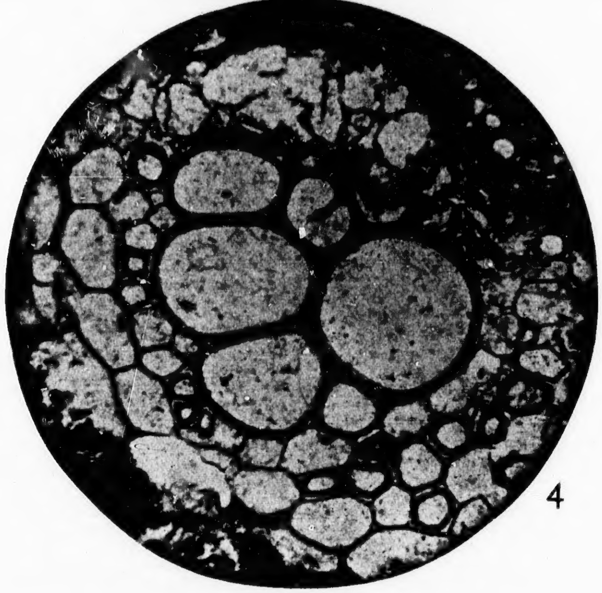

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MYELOPTERIS TOPEKENSIS Penhallow.